Fabrication of a Micro-Beam MEMS Sensor for Measurement of Thermal Conductivity of Fluids

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This paper demonstrates fabrication of a MEMS sensor and its performance in measuring thermal conductivity of gases and liquids. The sensor, named the micro-beam sensor, was fabricated with a gold strip suspended across a trench on a silicon substrate. The size of the sensor was ~70 nm in the thickness, ~0.4 mm wide and ~10 mm long. To measure the thermal conductivity of a fluid, the temperature of the sensor was determined from the electric resistance after being heated in a test fluid by a direct current. The advantage of using the micro-beam sensor is that the measurement is done at a steady state that is achieved within less than 1 ms and last for a long time without the effect of free convection. The electric resistance and the thermal conductivity of the sensor were determined at first as a function of temperature by a preliminary experiment in a vacuum chamber. The experiments were then conducted with air, FC-72 and ethanol as test fluids. The temperature of the sensor was constant during heating, indicating no occurrence of free convection. The temperature of the sensor was higher in the fluid with lower thermal conductivity. Its dependence on the thermal conductivity of fluids was similar to that obtained by the numerical simulation of the heat conduction around the sensor. The procedure was finally proposed to determine the thermal conductivity of the test fluid by the measurement of the electric resistance at different heating powers.